

WHAT IS CLAIMED IS:

1. An image processing method for detecting a linear object on a gray-scale image,

wherein edge pixels of the gray-scale image are extracted, and while considering the extracted edge pixels sequentially, an edge pixel verified to have a density gradient direction opposite to the edge pixel under consideration is searched for within a predetermined range in the direction orthogonal to the edge direction from the edge pixel under consideration, and when an edge pixel satisfying the verification conditions is extracted, a line segment is set in parallel to the edge direction of the edge pixel under consideration and passing through a predetermined position from the extracted edge pixel to the edge pixel under consideration, and

wherein an image indicating the result of setting the line segment is displayed as a linear object detection result when there is no edge pixels to be considered.

2. The image processing method according to claim 1, wherein the input of a numerical value indicating the conditions for setting the search range in the search process is received.

3. The image processing method according to claim 1, wherein the input of a numerical value indicating the conditions for setting a line segment is received.

4. The image processing method according to claim 1,

wherein an image indicating the result of setting the line segment is produced by adding a numerical value corresponding to the edge intensity of the edge pixel under consideration to the density value of the pixels constituting the line segment to be set in the line segment setting process.

5. The image processing method according to claim 4, wherein an image indicating the result of setting the line segment is binarized by a predetermined threshold value when there is no edge pixels to be considered, and the resultant binary image is displayed as a linear object detection result.

6. The image processing method according to claim 1, wherein the edge intensity of the edge pixel under consideration is reflected in selected one of the length and the width of the line segment to be set in the line segment setting process.

7. The image processing method according to claim 1, wherein upon extraction of an edge pixel satisfying the verification conditions by the search process, the edge pixel extracted is set as a considered edge pixel after the line segment setting process.

8. An image processing method for detecting a linear object on a gray-scale image, wherein edge pixels of the gray-scale image are extracted, and while the extracted edge pixels are

sequentially considered, an edge pixel verified to have a density gradient direction opposite to an edge pixel under consideration is searched for within a predetermined range in the direction orthogonal to the edge direction of the edge pixel under consideration, and upon extraction of an edge pixel satisfying the verification conditions, a line segment is set which is in parallel to the edge direction of the edge pixel under consideration and passes through a predetermined position from the extracted edge pixel to the edge pixel under consideration, and

wherein selected one of the position and the size of the linear object on the gray-scale image is detected based on the result of setting the line segment when there is no edge pixels to be considered.

9. The image processing method according to claim 1, comprising the steps of:

inputting a predetermined number of gray-scale images including an image of a linear object;

receiving the operation of designating a linear object on each of the gray-scale images;

executing the search process and the line segment setting process for each of the input gray-scale images while changing the values of the parameters for the respective processes, and executing the linear object detection process based on the result of setting the line segment; and

selecting an optimum set of parameter values based on the result of detecting and designating a line object for each gray-scale image;

wherein the parameters for the search process are numerical values indicating the search range setting conditions, and the parameters for the line segment setting process are numerical values indicating the line segment setting conditions.

10. An apparatus for detecting a linear object on a gray-scale image, comprising:

image input means for inputting a gray-scale image to be processed;

display means for displaying the result of detecting a linear object in the input gray-scale image;

edge pixel detection means for detecting edge pixels on the gray-scale image;

search means for considering a predetermined edge pixel and searching for an edge pixel verified to have a density gradient direction opposite to the edge pixel under consideration within a predetermined range in the direction orthogonal to the edge direction of the edge pixel under consideration;

line segment setting means for setting a line segment parallel to the edge direction of the edge pixel under consideration at a predetermined position from the extracted edge pixel to the edge pixel under consideration upon

extraction of an edge pixel satisfying the verification conditions by the search means; and

control means for sequentially considering the edge pixels detected by the edge pixel detection means, activating the search means and the line segment setting means, and displaying on the display means an image indicating the result of setting the line segment by the line segment setting means when there is no edge pixels to be considered.

11. The image processing apparatus according to claim 10, further comprising:

input means for inputting the parameters used for the process of detecting a linear object;

wherein the input means inputs a numerical value indicating the search range setting conditions as a parameter for the search process executed by the search means.

12. The image processing apparatus according to claim 11,

wherein the input means inputs a numerical value indicating the line segment setting conditions as a parameter for the line segment setting process executed by the line segment setting means.

13. The image processing apparatus according to claim 10,

wherein the control means extracts the pixels which

constitute at least a predetermined number of line segments set by the line segment setting means and superposed one on the other when there is no edge pixels to be considered, and generates and displays on the display means a binary image by separating the extracted pixels from other pixels.

14. The image processing apparatus according to claim 10,

wherein the line segment setting means adds a numerical value corresponding to the edge intensity of an edge pixel under consideration to the density value of the pixels constituting a line segment to be set and generates an image indicating the result of setting the line segment.

15. The image processing apparatus according to claim 10,

wherein the line segment setting means adds a numerical value corresponding to the edge intensity of an edge pixel under consideration to the density value of the pixels constituting a line segment to be set and generates an image indicating the result of setting the line segment, and the control means binarizes an image indicating the result of setting the line segment by a predetermined threshold value when there is no edge pixels to be considered and displays the resulting binary image on the display means.

16. The image processing apparatus according to claim 10,

wherein the control means includes a post-consideration setting means which upon extraction of an edge pixel satisfying the verification conditions by the search means, sets the extracted edge pixel as a post-consideration edge pixel after complete execution of the line segment setting process by the line segment setting means.

17. The image processing apparatus according to claim 10, further comprising:

detection means for detecting selected one of the size and the position of a linear object on the gray-scale image based on the result of setting a line segment by the line segment setting means.

18. The image processing apparatus according to claim 17, further comprising:

determining means for determining the presence or absence of a linear object based on the detection result of the detection means and output means for outputting the result of determining the presence or absence by the determining means.

19. The image processing apparatus according to claim 10, further comprising:

parameter setting means for setting an optimum value of each parameter in numerical value indicating the search range setting conditions in the search process by the search means and the line segment setting conditions in the

line segment setting process by the line segment setting means;

wherein the parameter setting means includes designating operation means for performing the operation of designating the linear object on a gray-scale image including the linear object input by the image input means, detection control means for operating the search means and the line segment setting means while changing the values of the parameters for the process executed by the search means and the line segment setting means for a plurality of gray-scale images subjected to the designating operation, while at the same time executing the linear object detection process based on the result of setting the line segment, and select means for selecting an optimum set of parameter values based on the detection result for each gray-scale image and the result of designating the linear object.